

Ten (Two) Statistics You Need to Know

Mark B. Stephens, MD MS
FAAFP

Assoc. Prof. Family Medicine
USU

OIC-Flight Line Clinic
Sigonella Sicily

**“There are lies,
darn lies and
statistics”**

Objectives

- Understand how to **use** statistics not how to **perform** statistics (except one!)
- Review 11 statistical tests/principles that will aid you in the review and interpretation of the medical literature (and more importantly in the care of your patients)
 - Drive home with “two most important”.

5 Common Statistical “Cheats”

1. Dump all results into the computer vortex and spit out anything with a $p < 0.05$
2. Fail to correct for baseline differences in groups
3. Fail to report Confidence Intervals (especially when they include 1.0).
4. Subgroup analysis post-hoc (see #1)
5. If the results don't support your hypothesis, try again with 'advanced statistical techniques'

Lecture Outline

- Ignore parametric vv non-parametric testing
- 4 tests to quantify risk, benefit and harm
 - RRR/ARR/NNT/OR
- 5 tests to describe Diagnostic Testing
 - Sn; Sp; PPV; NPV; Pre-test probability
- Confidence Intervals
- P-value

Quantifying Risk and Benefit

Which of these 4 'guidelines' is best?

1. Reduced the rate of deaths by 20%
2. Produced an absolute reduction in deaths of 3%
3. Increased patient survival rate from 84% to 87%
4. Enrolled 31 patients to prevent one death

CABG AND SURVIVAL

		OUTCOME		TOTALS
		DEAD	ALIVE	
TREATMENT	MEDICATIONS (Control)	A 404	B 921	1324
	SURGERY (Experimental)	C 350	D 974	1325
	TOTALS	A + C	B + D	A+B+C+D

$$\text{CER} = 404/1324$$

$$\text{EER} = 350/1325$$

Event Rates (Establish the Baseline)

1. Control Event Rate (CER)
 - CER (risk of death with med management) = $404/1324 = .30 = 30\%$
2. Experimental Event Rate (EER)
 - EER (risk of death with surgery) = $350/1325 = .26 = 26\%$
3. **Relative Risk** = CER/EER
 - $.26/.30 = .87$ or 87%
 - In other words, the relative risk of death in the surgery group is 87% that of the medication management group

Relative Risk Reduction

- The *percent* reduction in events in the treated group compared with the control group

$$RRR = |EER - CER| / CER * 100$$

$$|.26 - .30| / .30 = \mathbf{13\% \text{ Relative Risk Reduction}}$$

Absolute Risk Reduction

- Absolute Risk Reduction (ARR) is the absolute amount by which a particular treatment reduces the risk of a bad outcome

$$ARR = |EER - CER|$$

		OUTCOME		TOTALS
		DEAD	ALIVE	
TREATMENT	MEDICATIONS	404	921	1324
	SURGERY	350	974	1325
	TOTALS	A + C	B + D	A+B+C+D

Absolute Risk Reduction = CER - EER

$$\text{ARR} = |.26 - .30| = .040 = 4\%$$

Odds Ratios

- Odds of experimental patient suffering an adverse event compared to control patient
- Used to relate results of cohort studies

Odds Ratios

- If a horse wins 2 of every 5 races, it goes off as a 2:3 favorite
- Compares the presence of an exposure to the absence of an exposure given that we already know about the outcome

		OUTCOME		TOTALS
		DEAD	ALIVE	
TREATMENT	MEDICATIONS	404	921	1324
	SURGERY	350	974	1325
	TOTALS	A + C	B + D	A+B+C+D

Odds Ratio (OR): $= (a/b)/(c/d) = ad/bc$

Odds Ratio $= (404/921)/(350/974) = 1.22$

Number Needed to Treat

- The Number Needed to Treat (NNT) is the number of patients you need to treat to prevent one additional bad outcome
 - Principle can be extended to Number Needed to Harm (NNH) or Number Needed to Screen (NNS)

$$\text{NNT} = 1/\text{ARR}$$

NNT

- Important way of 'measuring' the effectiveness of interventions. Easy to comprehend.
 - How many patients do I need to treat to prevent one outcome?
- Describes the difference between treatment and control in achieving a particular outcome.
- NNT's from systematic reviews are at the pinnacle of the evidence pyramid.

		OUTCOME		TOTALS
		DEAD	ALIVE	
TREATMENT	MEDICATIONS	404	921	1324
	SURGERY	350	974	1325
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$$\text{NNT} = 1/\text{ARR}$$

$$\text{NNT} = 1/.04 = 25$$

RRR; ARR; OR; NNT

- Different ways of expressing the same information
 - Pharmaceutical Detailing
 - Academic Detailing
 - Personal Pontification
- Confusing for providers and patients alike!!

USE THE NNT!

Diabetic Retinopathy Incidence in 5 years (DCCT)				
Usual Insulin Therapy (CER)	Intensive Insulin Therapy (EER)	Relative Risk Reduction (RRR)	Absolute Risk Reduction (ARR)	Number Needed to Treat (NNT)
38%	13%	66% $\frac{ EER - CER }{CER}$	25% $ EER - CER $	4 1/ARR

Confidence Intervals

Confidence Interval- Example

- 9,297 patients were recruited into a randomised-blinded-clinical trial examining mortality and treatment with a particular blood pressure medication
- How do you interpret the following results:

CI-Example

Result	Drug A (EER)	Placebo (CER)	RR (CI)
CV event	651	826	.78 (.7-.86)
Non-CV Death	200	192	1.03 (.85- 1.2)
All-cause	482	569	.84 (.75-.95)

$$RR = EER/CER$$

Confidence Intervals

- A numeric range of values for which we can be 95% (typically) certain that the mean values for a population will fall. Provides a plausible range of values for the 'unknown' parameter.
- Quantifies uncertainty in measurement
- Larger sample sizes produce narrower confidence intervals and increase 'precision' of estimate

Confidence Intervals

- Are preferable to p-values as they tell the range of possible effect sizes
- Any confidence interval that contains the value of no difference (1.0) indicates that the treatment under investigation potentially does not differ from the control.

Convert to NNT!

- Outcome of interest is CV Event
 - $N = 4,648$ in treatment group; $4,649$ in control group
 - $EER = 651/4,648$ $CER = 826/4,649$
 - $RRR = |EER - CER| / CER$
 - $ARR = |EER - CER|$
 - $NNT = 1 / ARR$

Crunching the Numbers

$$\text{EER} = .14$$

$$\text{CER} = .18$$

$$\text{RRR} = |.14 - .18| / .18 = 22\%$$

$$\text{ARR} = |.14 - .18| = 4\%$$

$$\text{NNT} = 1 / .04 = 25$$

p-value

p-value

- The likelihood that the results of a particular study would occur by chance alone
 - Type I error
 - Arbitrarily defined. By convention, usually set at 1 in 20—this is the $p < 0.05$.
 - This is a single, arbitrary cutpoint—why base your clinical decisions on one point, when you can use a continuum? (The Confidence Interval).

- By themselves, p-values tell you nothing about the magnitude of difference, nor the direction of the difference in treatment effect
- The p-value complements the Confidence Interval and should be reported as such.

Diagnostic Testing

Sensitivity

- The proportion of people with a particular disorder who have a positive test
- “Positivity in Disease-PID”
- SnTP
- SnOUT. When a test has high sensitivity, a negative result essentially rules out disease.

Diagnostic Testing

		Target Disorder		TOTALS
		Present	Absent	
Test Result	Positive	A	B	A + B
	Negative	C	D	C + D
	TOTALS	A + C	B + D	A+B+C+D

Sensitivity: $a/(a+c)$.

Specificity: $d/(b+d)$

Likelihood ratio for positive test = $S_n/(1-S_n)$

Likelihood ratio for negative test = $(1-S_n)/S_n$

Positive predictive value = $a/(a+b)$

Negative predictive value = $d/(c+d)$

Specificity

- The proportion of people without a particular disease who have a negative test
- “Negativity in Health—NIH”
- SpIN—If a test has high specificity, a positive result essentially rules in the diagnosis.

Diagnostic Testing

		Target Disorder		TOTALS
		Present	Absent	
Test Result	Positive	A	B	A + B
	Negative	C	D	C + D
	TOTALS	A + C	B + D	A+B+C+D

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Negative predictive value = $d/(c+d)$

Positive/Negative Predictive Values

- PPV = proportion of people with disease who have a positive test.
- NPV = proportion of people without disease who have a negative test.

Diagnostic Testing

		Target Disorder		TOTALS
		Present	Absent	
Test Result	Positive	A	B	A + B
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	TOTALS	A + C	B + D	A+B+C+D

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Pretest Probability

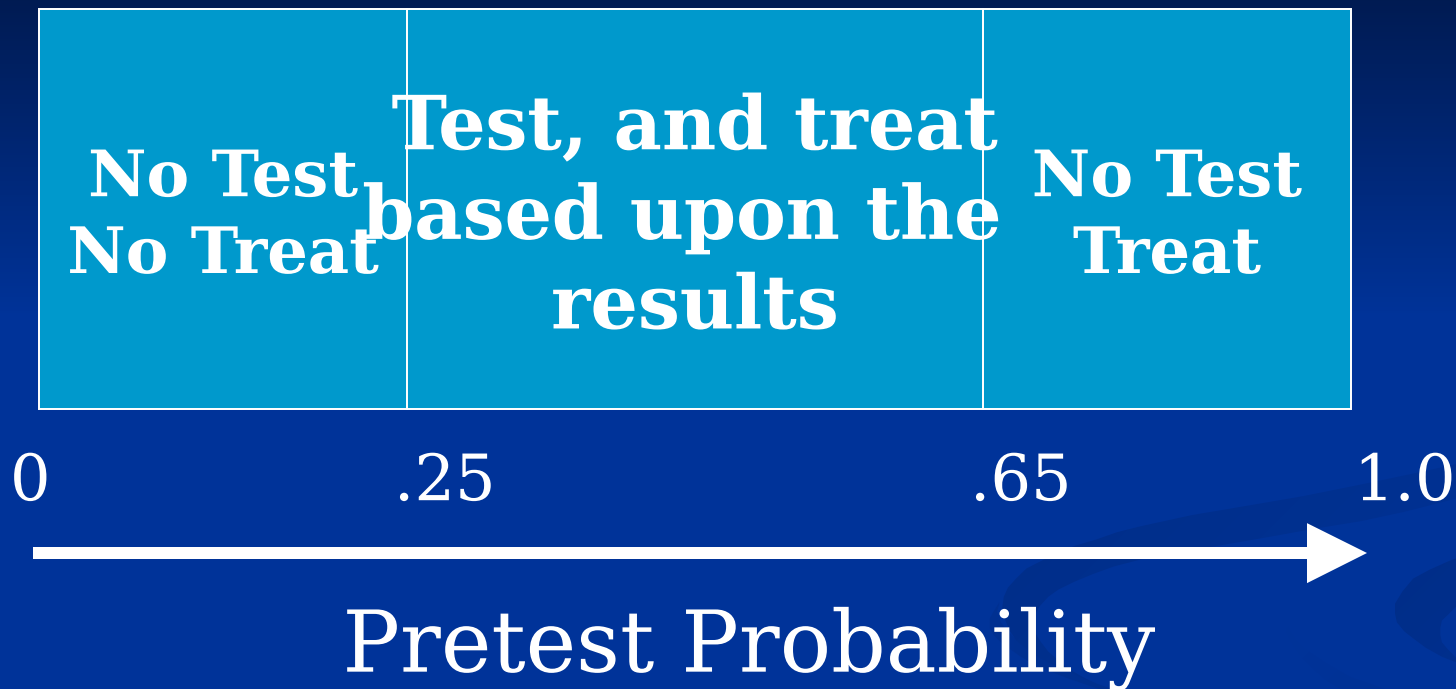
- What is the probability that a patient has a particular disease ***before*** you apply the results of an individual test?
 - Clinical experience
 - Regional/national statistics
 - Medical literature estimates

Pretest Probability

- Pretest probability within the context of the sensitivity and specificity of the diagnostic test determine whether or not the test will help you manage your patient

Example

- 9-yo male presents with one day history of sore throat and fever. No antecedent URI symptoms. Exam shows tonsillar exudate, anterior cervical adenopathy and palatal petechiae
 - Would you order a rapid strep test?
 - Would you order a formal throat culture?



~~Two~~ (Three) Statistics You Need to Know

1. Number Needed to Treat
2. Confidence Interval
3. Pretest Probability
(Diagnostic Testing)

Questions?

Relative Risk Reduction: Example

- An analgesic medication is compared to placebo in two groups of 100 patients. 70 patients taking the analgesic medication are afforded pain relief within 2 hours. 20 patients taking placebo are afforded relief in 2 hours.
- How do you interpret these results?

		OUTCOME		TOTALS
		Relief	No Relief	
TREATMENT	Analgesia	70	30	100
	Placebo	20	80	100
	TOTALS	A + C	B + D	A+B+C+D

$$RRR = (CER - EER) / CER * 100$$

$$RRR = .20 - .70 / .20 * 100$$

$$RRR = 250\%$$

ARR Example

- An analgesic medication is compared to placebo in 100 patients. 70 patients taking the analgesic medication are afforded pain relief within 2 hours. 20 patients taking placebo are afforded relief in 2 hours.
- How do you interpret these results?

ARR

- $ARR = \text{Control Event Rate} - \text{Treatment Event Rate}$

$$ARR = |20-70|/100 = 50\%$$

NNT Example

- An analgesic medication is compared to placebo in 100 patients. 70 patients taking the analgesic medication are afforded pain relief within 2 hours. 20 patients taking placebo are afforded relief in 2 hours.
- How do you interpret these results?

Example

- ARR (Absolute Risk Reduction) =
Control event rate - Treatment event
rate/100
 - $ARR = |20-70| = 50/100 = .5$
 - $NNT = 1/.5$
 - $NNT = 2$